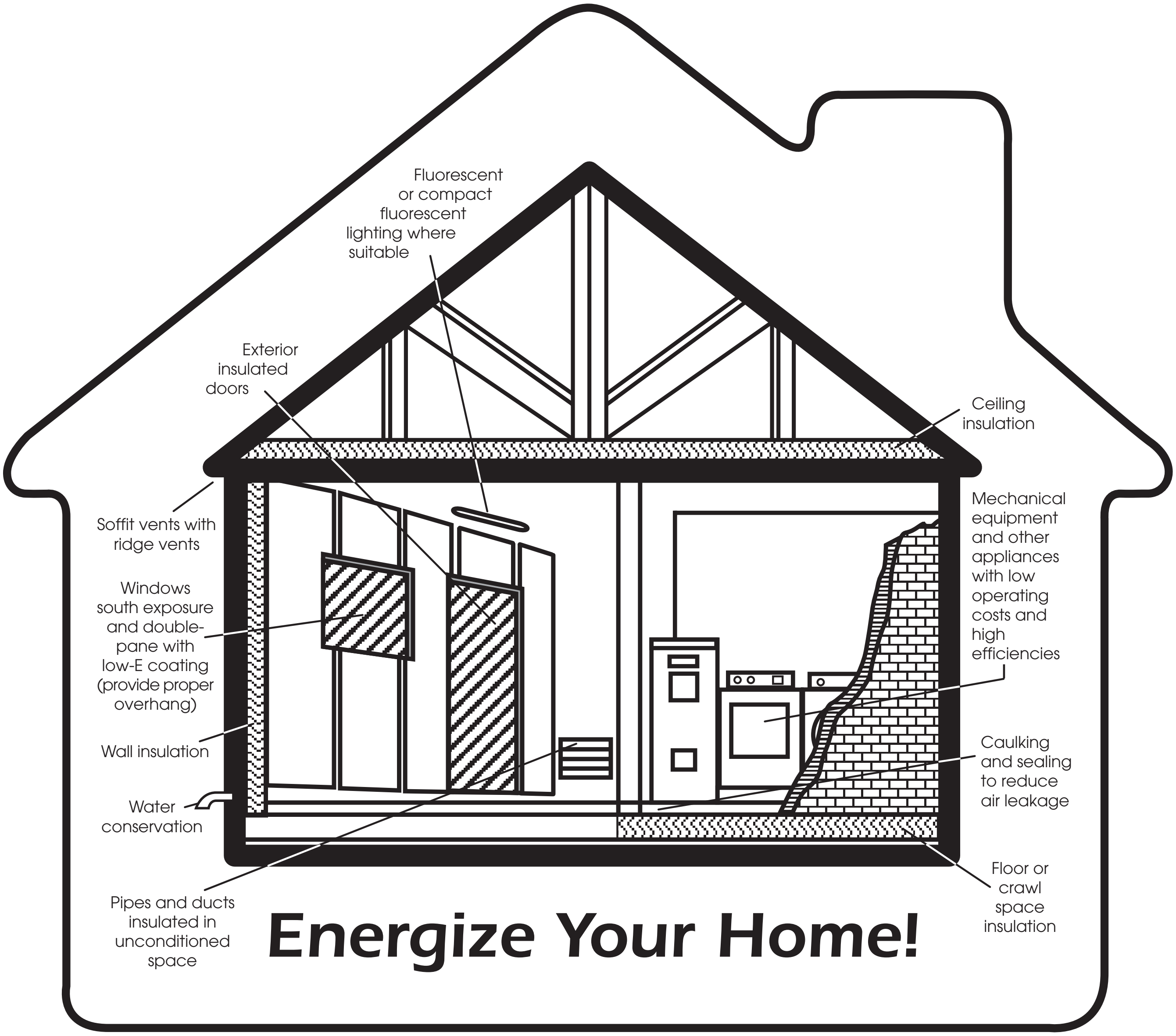
Energy Management Handbook for Homeowners



Energy Center

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Missouri Department of Natural Resources

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Energy Center

Basic Energy Concepts

Making your home as energy-efficient as possible is only a part of the process of achieving a more comfortable and less expensive home to operate. Your family's habits and the weather are important in determining energy usage.

This booklet is designed to help you implement retrofit measures as well as evaluate your family's habits in how they use energy and water.

Temperature control is the largest use of energy in a residence. Heat flow always goes from warm areas (inside homes in winter) to cooler ones. This flow of heat can be slowed by something such as insulation that will resist rapid airflow movement.

Most homes are heated with gas and/or electricity, but all heat is measured in British thermal units (Btu). Btus are very small (about the heat energy of one wooden kitchen match); therefore, over the period of a year, millions of Btus are consumed to heat water or living space.

Heat Loss

A typical home loses heat by a combination of three basic heat-transfer processes:

1. CONDUCTION through materials and substances.
2. CONVECTION or transference of heat because of differences in density. This is what people mean when they say heat rises. Actually, warm air (or less dense air) rises. Heat is lost in all directions to cooler areas. Convection heat losses can cause infiltration.
3. RADIATION of heat occurs when heat flows from warm surfaces to cool surfaces independent of the medium between them (such as a warm roof to the clear night sky, or a window surface to the outside air).

Insulation will slow heat loss. Air is a very poor conductor of heat; that's why it is a good insulator. When air pockets are trapped (inside insulation or between panes of glass), they retard the flow of heat. It's not the substance itself (glass fiber, cellulose, rockwool or foam insulation) that slows heat loss, but the trapped pockets of air that are in or between these materials.

Resistance (R) to heat flow is measured in how many hours it takes one Btu to go through one square foot of a material that is one inch thick and experiencing a one-degree temperature difference. A window that has an R-value of 2 loses heat ten times faster than a wall with an R-value of 20.

When you are air conditioning your home, the reverse heat flow occurs from outside to inside the house. Insulation slows that heat flow also.

Indoor Humidity

Relative humidity is an important comfort factor. A higher relative humidity in winter will make your home feel warmer, and a lower summer humidity will let you feel cooler at moderate temperatures. Savings in energy result from turning the thermostat to a lower winter setting or a higher summer setting.

Weather

The weather – temperature, relative humidity, wind, cloud cover and sunshine – affect the energy used in maintaining home comfort. Most space heating begins at 65°Fahrenheit. As the outdoor temperature falls below this base, the space heating load increases in proportion to the difference between the two temperatures. This relationship between load and temperature led to the engineering concept of the heating degree-day, or heating degree-hour as an index of the intensity and duration of cold weather. It is defined as the difference between the average temperature for a 24-hour time period and the base temperature of 65°F.

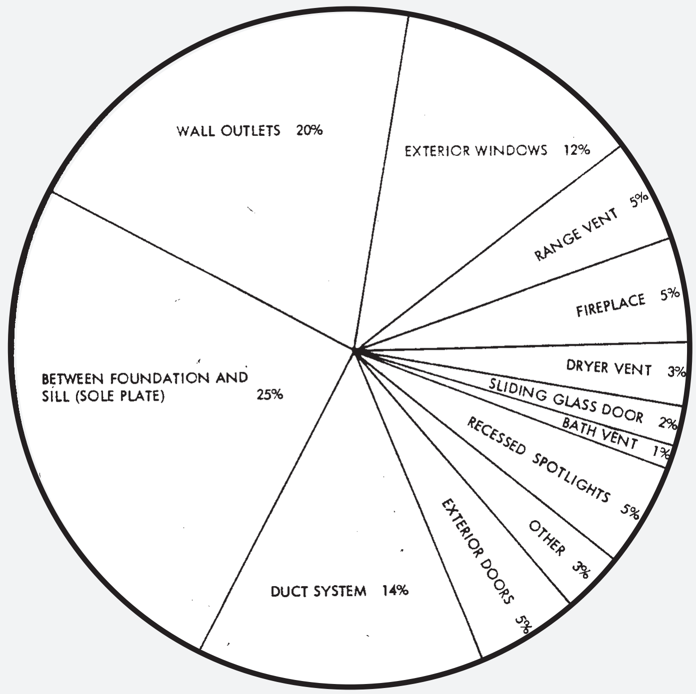
The degree-hour concept is somewhat more accurate during periods of "marginal" heating (or cooling) demand.

Cooling degree-hours are computed using both an outside temperature and relative humidity. These are shown on your summer utility bill.

Depending on the size and type of home construction, about one-fourth of heating costs are attributable to heating infiltration air (uncontrolled air leakage) in residences.

TYPICAL AIR LEAKAGE IN THE HOME

This chart indicates typical infiltration in homes. The areas where heat is lost in the winter and gained in the summer (due to free air flow openings) are shown in the pie.



Ratings	Per Hour Air Changes	Comments
Poor or greater	1 to 2	Very leaky house with obvious visible cracks, no weatherstripping or caulking visible, no fireplace damper, windy site.
Fair	1.0	Some attention has been placed on controlling air leakage. Some visible weatherstripping and/or caulking. Fireplace has operable damper.
Average	0.85	Carefully weatherstripped and caulked, also has sealed double-pane windows. Molding at base of wall and the sill plate are caulked, as well as window and door frames. Wall outlets are sealed or gasketed. Fireplace is sealed, or air-tight wood-burning stove is used to control air leaking up the stack.
Good	0.65	Above, plus wall and attic vapor barriers. Double-door entry porch reduces air losses when door is opened. Combustion heating devices use outside air, and, where applicable, stack dampers.
Very Efficient	0.5 or less	Above, but vapor barrier is continuous (all penetrations sealed, barrier is overlapped, taped and caulked). Because of possible problems with indoor air-pollution buildup in low infiltration houses, mechanical ventilation, in the form of an efficient air-to-air heat exchanger, should be installed.

New-Home Construction

In most homes, the air inside is replaced about once every two hours, which adds up to about 25 percent of the total heating load. Installing an airtight vapor barrier at the time of construction, adding insulation, sealing doors and windows with weatherstripping, and caulking will reduce the incoming flow of air, thereby reducing the amount of energy required to heat the air.

A disconcerting side effect of airtight, energy-efficient homes is indoor air pollution. Unwholesome gases, small particles of matter, offensive odors, and moisture can be trapped inside your home. This may lead to discomfort and even harmful health effects.

Most consumers do not realize that invisible gases are found in the home. For example, formaldehyde is used as a bonding agent in some foam insulation. Carbon dioxide is a by-product of breathing. Carbon dioxide, nitrogen oxides and other compounds are products of combustion. These gases, along with carbon monoxide, can accumulate.

One way to reduce the heat loss but preserve air quality is to use an air-to-air heat exchanger to transfer the heat from the outgoing stale, warm air to the incoming cold air.

For new home construction, consider the following features to reduce air leakage but preserve air quality:

1. Use weatherstripping on all exits.
2. Use sealed windows.
3. Avoid sliding patio doors.
4. Ensure a complete vapor barrier seal around the house.
5. Use a recirculating range hood for the kitchen.
6. Vent the bathroom fans into the heat exchanger.
7. Vent electric dryers into the heat exchanger.
8. If using fuel-burning furnaces, isolate the combustion air and chimney air from the house air.
9. Install an air-to-air heat exchanger.
10. Avoid recessed lighting.

Caulking

Caulking is an easy, energy-saving project you can do yourself. It is relatively inexpensive – and very effective. In fact, it will usually pay for itself in energy savings within one year.

Caulk is a compound used for filling cracks, holes, crevices and joints on both the inside and outside of your home. You will need only a few simple tools and a minimum of skill to caulk these areas. Start at the back of your house and work toward the front so that your skill level is improved by the time you caulk places that are visible.

Try to choose a mild day to tackle this project. The outside temperature should be above 40°F for the caulk to be applied correctly. So, plan to caulk during the spring, summer or fall for best results. Old, cracked caulk should be removed before new is applied. Check your home repair center for a "puttying tool" that will make the job easier and provide a more professional look.

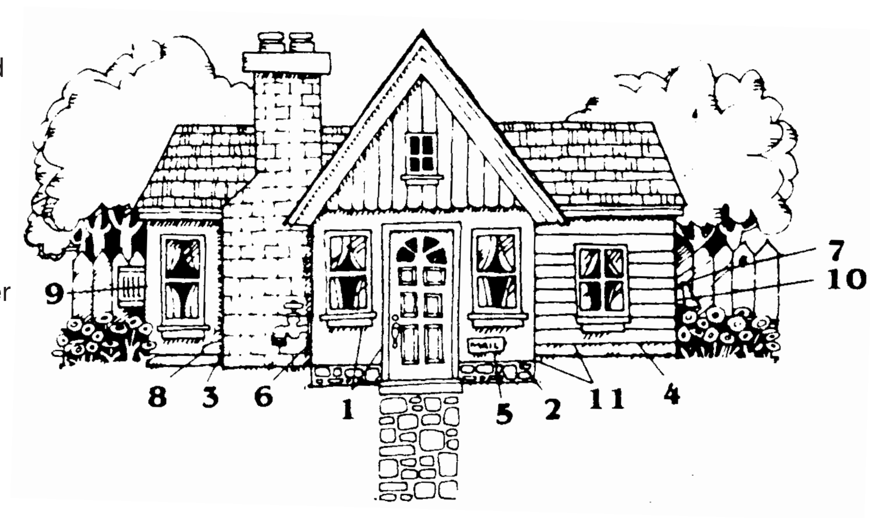
Where to Caulk

As a general rule, caulk should be applied wherever two different building materials meet on the interior or exterior of your home. Different building materials expand and contract at various rates. Through the years, with temperature extremes and caulk drying out, cracks develop between materials. Because these cracks allows air infiltration, the cracks need to be caulked.

On the interior of your home, you can check for air leakage by moving your hand around the windows and doors on a windy day. If you can feel air movement, you need to caulk and/or weatherstrip. You will probably be surprised to find how many spots are "air leakers!"

The following are areas that should be checked:

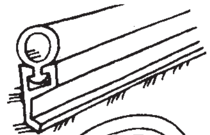
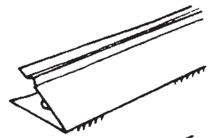
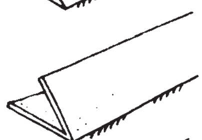
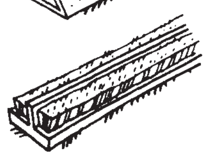
1. Around door and window frames – inside and out; check window pane putty.
2. Places where brick and wood siding meet.
3. Joints between the chimney and siding.
4. Between the foundation and walls.
5. Around mail chutes.
6. Around electrical and gas service entrances, cable T.V. and phone lines, and outdoor water faucets.
7. Where dryer vents pass through walls.
8. Cracks in bricks, siding, stucco and foundation.
9. Around air conditioners.
10. Around vents and fans.
11. Wherever two different materials meet.



The material used in sealing air leaks depends on the size of the gaps and where they are located. Caulk is best for cracks and gaps less than 1/4" wide. Expanding foam sealant is good for sealing larger cracks and holes that are protected from sunlight and moisture. Rigid foam insulation may be used for sealing very large openings such as plumbing chases and attic hatch covers. Fiberglass insulation can also be used for sealing large holes, but it needs to be wrapped in plastic or stuffed in plastic bags because air can leak through fiberglass.

Caulk/Weatherstrip

Types of Weatherstripping

Weatherstripping		Durability	Comments
Rolled vinyl with rigid metal backing		5 years and up	Must make contact for proper seal. Visible when installed
Foam rubber		1-2 years	Easy to apply. Short life span.
Thin spring metal		5 years and up	May lose some flexibility with time and, therefore, lose its sealing ability.
Spring plastic		5 years and up	Easy to apply.
Fin seal (nylon brush with thin plastic strip down the middle)		5 years and up	Used to replace worn weather-stripping on aluminum horizontal sliding windows and sliding glass doors.

Types of Caulking Compounds

Compound	Durability	Elasticity	Cost	Comments
Oil based	1-5 yrs	Poor	Low	Very low elasticity.
Acrylic latex	2-10 yrs	Fair to good	Moderate	Easy to apply, water clean-up, paintable.
Butyl rubber	5-10 yrs	Fair	Moderate	Difficult to apply, solvent clean-up, high moisture resistance.
Polyurethane	20 yrs	Excellent	Moderate to high	Solvent clean-up, excellent elasticity, adheres well to most surfaces.
Silicone	20 yrs+	Excellent	High	Paintable silicone available; also available in clear.

Air conditioning is the second largest energy expense in most homes.

The biggest sources of unwanted summer heat in homes are windows and walls (20 to 30 percent), internal gains from appliances and lights (15 to 25 percent), and through the roof (10 to 20 percent). In humid climates, damp outside air leaking into the house can also increase cooling load significantly.

Efficiency

Air conditioners are rated by their efficiency levels, Seasonal Energy Efficiency Rating (SEER – commonly pronounced SEAR). Ratings are shown on a yellow tag for room air conditioners and on fact sheets for central units. The SEER is the seasonal cooling output in Btus divided by the seasonal energy input in watt hours for an average U.S. climate. It takes into account the time the unit is not running. The higher the figure the better. A unit with a SEER of 12.0 costs half as much to operate as one with a SEER of 6.0. The higher initial cost of the higher SEER unit is normally paid back within a few years, making the more efficient equipment less expensive in the long run.

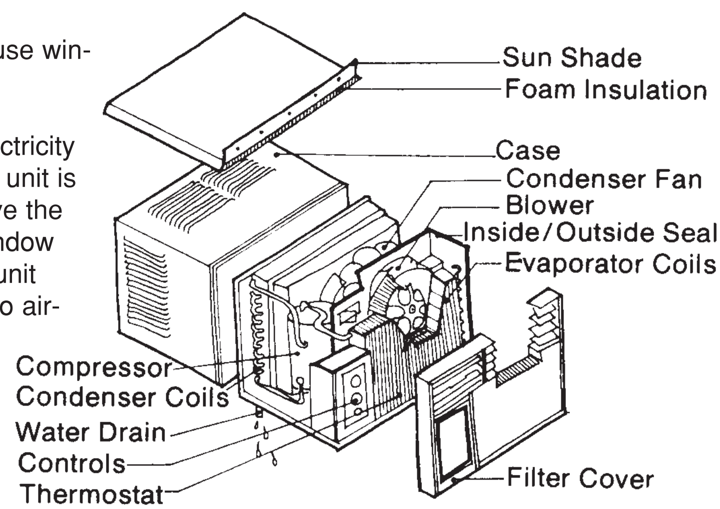
The Energy Policy Act of 1992 requires that central air conditioners manufactured after January 1994 attain at least a SEER of 10.

The ratings refer only to operating efficiency, or cost to operate, and have nothing to do with capacity, which is rated in Btus/hr. The Btu/hr figure indicates how much heat the air conditioner can remove from a room or house in an hour. Sometimes a tonnage figure is used instead of Btus/hr. One ton of air conditioning is the same as 12,000 Btus/hr.

Window Unit Versus Central Unit

The buyer must make a basic decision – whether to use window units or a central system. Both have advantages.

The big plus for **window units** is that they allow for zoned cooling. This can save substantial amounts of electricity and money. Also, the actual purchase price of a window unit is less than that of a central unit; however, you will not have the convenience or comfort of whole-house cooling. The window units are also noisier because the compressor is in the unit within the living space. However, window units require no air-ducting system as the central unit does and therefore have no duct losses. Window units can be installed through a wall in an enclosed space and ducted to one or two rooms.



WINDOW OR THROUGH-THE-WALL UNIT

Central units provide whole-house air conditioning, which may be desirable if many rooms are used on a fairly constant basis, or it may simply be the choice of the homeowner. Central units, with their larger size and capacity, cost more to buy, install and run.

When replacing a condenser (outside unit), the evaporator coil (inside the house at the air handler) should also be replaced. If this is not done, the air conditioner will not have its high efficiency.

Sizing

If you are installing or replacing a central unit, your contractor will perform the sizing calculations based on the size of the house, window exposure and orientation, construction materials, levels of insulation, air infiltration and lifestyle. In the past, it was standard practice to oversize the air conditioner by 10 percent to 50 percent. However, some researchers now believe that air conditioning systems undersized by 10 percent are more efficient and more effective in removing humidity. It is important not to oversize because such a unit, although it will cool the air, will not run for long enough periods to reduce the indoor humidity to a comfortable level. You may feel cool and clammy rather than cool and dry, a real comfort consideration in Missouri summers.

Dehumidification

Air conditioners remove moisture from the air by condensing water vapor as the air passes over cold coils. Water vapor condenses in the same way moisture from the air condenses on a glass of ice water on a hot, humid day.

Lowering the humidity makes you feel more comfortable, but it takes more energy, which reduces the efficiency of the air conditioner. One of the ways manufacturers have boosted air conditioner efficiency is by keeping the condenser coils somewhat warmer, which reduces condensation. Some of the new high-efficiency air conditioners do not dehumidify as effectively. Humidity can be reduced by including variable-speed or multi-speed blowers. Although there is no industry standard for rating the effectiveness of removing moisture, most literature does list water removal in pints per hour, which will help you compare one model to another. Some models have the fan speed controlled by a humidistat.

Placement and Maintenance

If possible, locate an outside compressor unit on the north side of the house. If that is not possible, try to position the compressor where it will be shaded as much as possible. Window units may not allow you the choice.

Outside compressors should be kept clean of leaves, twigs and grass cuttings so the compressor doesn't overheat. Mow grass so that cuttings are discharged away from the compressor unit, or brush or spray the cuttings off the compressor unit with a broom or a water hose.

Window units, if left in place during the winter, should be wrapped on the **inside**, and good weatherstripping should be used to block air infiltration around the unit. If wrapped on the outside, warm moist air from inside the home can condense and freeze inside the unit, possibly causing damage to the system.

For general seasonal maintenance, check the instruction manual. With central and window units, change the filters as often as once a month during the summer. Filters are inexpensive for what they give you – clean air, free of dust and pollen – and for what they do for the air conditioner – removing dirt or grit that wears out the moving parts prematurely, and producing a clear air flow for more efficient operation.

Operating Hints

When setting your thermostat, don't set the temperature colder than you want in hopes it will get cool faster – it won't.

Experiment a bit to determine the highest temperature setting at which you can be comfortable. Try 78°F to start. Every degree higher will save about 4 percent in operating costs.

One way to be comfortable with higher settings is to leave the fan setting on manual so it will run continuously. (The fan costs only one-fifth as much to run as the cooling compressor.) This will also help dehumidify. You may also run small fans.

If you have a whole-house fan (attic fan), you can save substantially on your electric bill by using the fan at night when weather conditions permit – usually when the outside temperature falls below 78°F, and the humidity is not oppressive. But early in the morning, before the temperature begins to rise, turn off the fan and close the windows to capture the cool air. With this charge of cool air, the house can "coast" without the air conditioner until late morning or early afternoon. (The whole-house fan should be insulated over if it is not used during the air conditioning season.)

When buying an appliance, you pay more than just the selling price; you commit yourself to paying the cost of running the appliance for as long as you own it.

These energy costs can add up quickly.

For example, running a refrigerator 15 to 20 years costs two to three times as much as the initial purchase price of the unit; and the 100-watt light bulb you bought for 50 cents will cost about $6 in electricity over its short life.

Life-cycle Costing

The sum of the purchase price and the energy cost of running an appliance over its lifetime is called its life-cycle cost. The life-cycle costs of energy-efficient appliances are lower than those of average models.

EnergyGuide Labels

When you shop for a major appliance, look for the yellow and black EnergyGuide labels (see page 9) that can help you choose the most efficient model you can afford.

Appliance labeling was mandated by Congress as part of the Energy Policy and Conservation Act of 1975. Labels must be displayed on seven types of major appliances. These seven major appliances account for about 73 percent of all energy consumed in American homes. New appliance labeling rules, passed in 1994 by the Federal Trade Commission to make energy-usage information easier to understand, began showing up on appliances on July 1, 1995.

The biggest change in the labeling of refrigerators, refrigerator/freezers, freezers, dishwashers, clothes washers and water heaters is a switch in the comparison base from an estimated annual operating cost of the appliance to its annual energy usage in kilowatt hours of electricity or therms of natural gas. Cost information will still be provided.

For Missouri residents in 1993, the average price for electricity was 7.3 cents/kWh and for natural gas was 53.5 cents/therm.

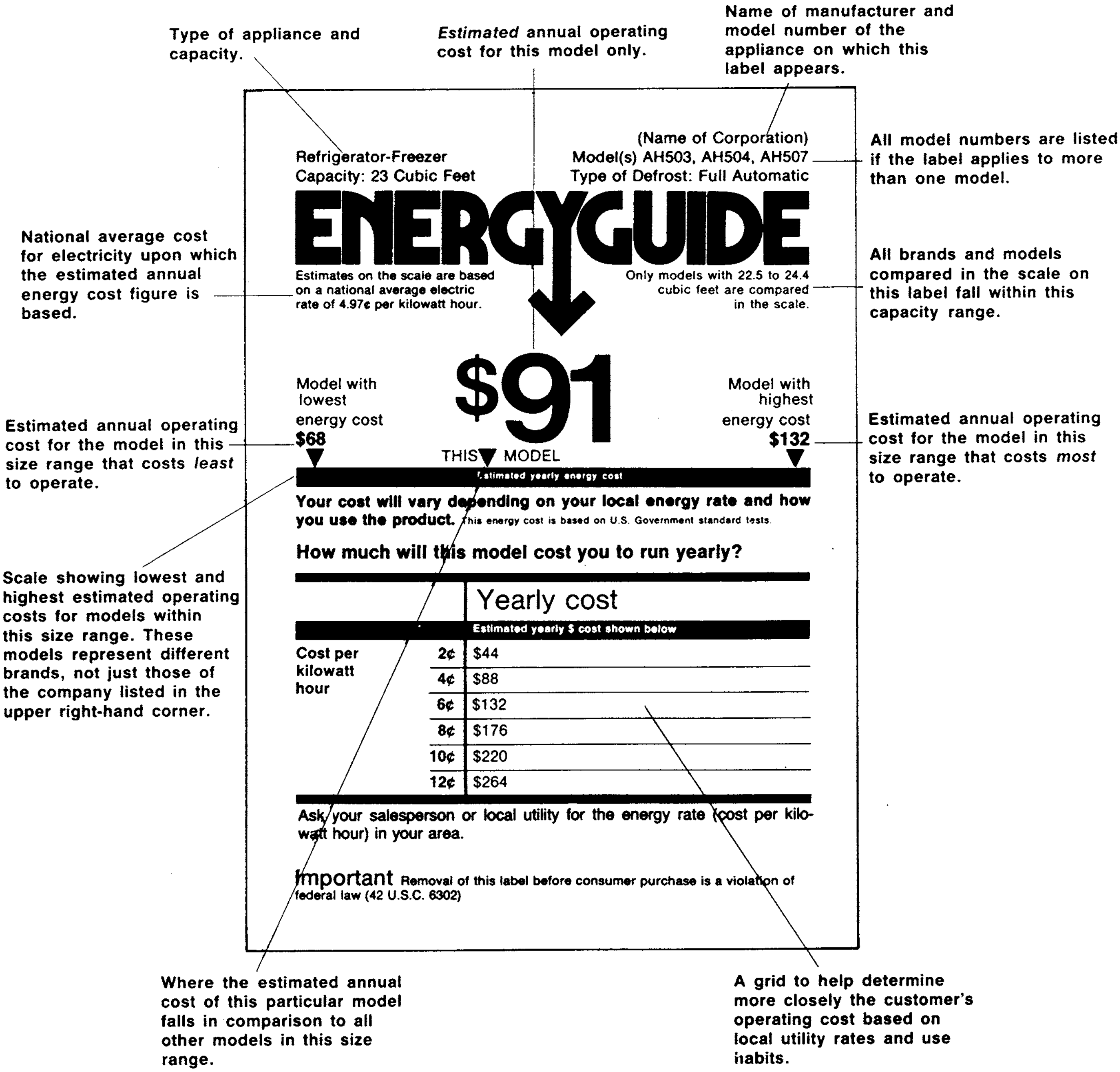
Federal law requires that EnergyGuide labels be placed on all new refrigerators, freezers, water heaters, dishwashers, clothes washers, room and central air conditioners and heat pumps.

For additional information, you may contact the American Council for an Energy Efficient Economy or the Association of Home Appliance Manufacturers for up-to-date information on appliance efficiency.

The American Council for an Energy Efficient Economy
1001 Connecticut Ave., NW, Suite 535
Washington, D.C. 20202
Phone (202) 429-8873

Association of Home Appliance Manufacturers
20 North Wacker Dr.
Chicago, IL 60606
Phone (312) 984-5800

The EnergyGuide Label



Selecting a Refrigerator/Freezer

The energy usage by refrigerators and freezers has decreased, but they are still among the largest energy users in the home. In 1990 and 1993, National Appliance Efficiency Standards specified the maximum electricity consumption of refrigerators according to volume and features.

When shopping for a new refrigerator or freezer, shop around using the EnergyGuide labels. There is still a wide variation in energy usage, and your choice of style and features will have an effect on energy usage. Side-by-side models use more energy. Manual defrost models often use half as much energy as automatic defrost models but are not widely available in large sizes. If you allow frost to build up, the refrigerator will rapidly lose efficiency. Features such as automatic icemakers and through-the-door ice and water dispensers can increase energy consumption. Usually, the larger the model, the greater the energy usage.

As a rule of thumb, you need eight cubic feet of refrigerator space for a family of two, plus one cubic foot for each additional person. Add two cubic feet if you entertain a great deal. Two cubic feet per person is usually required in freezer space.

Operating Hints

- If possible, locate the refrigerator and freezer away from heat sources and direct sunlight. Allow at least one inch of space on all sides of the refrigerator or freezer.
- Seriously evaluate the need for a second refrigerator. You may nearly double your electric bill.
- A refrigerator or freezer in an unheated garage will use more electricity in the summer than the winter.
- Clean around the condenser once a year, and keep the coils and grills dust-free.
- If the model has an energy-saver switch, you can reduce the usage by about 10 percent. Heaters, used in humid climates as an anti-sweat feature, are not needed most of the year or in air conditioned homes. The switch for the heaters may be labeled other than “energy saver.” If the switch has settings that say “dry/humid,” make sure it is set on “dry.” If it is labeled “power miser” or “energy saver,” turn the switch “on” to turn the heaters off.
- Keep the door gasket clean and in good shape; replace if it is damaged.
- As a general rule, refrigerator thermostats should be set in the 32°F to 40°F temperature range. Usual temperature of the freezer area in a conventional refrigerator is 10°F to 25°F; freezer sections of a refrigerator/freezer, about 5°F; and separate freezers, 0°F.
- Avoid overcrowding, which reduces airflow.
- Avoid opening the doors often by planning ahead, and do not let the refrigerator door stand open.
- Let hot dishes cool slightly before putting in the freezer or refrigerator.
- In frost-free refrigerators, it is important to cover foods before placing them in the refrigerator.
- Thaw foods in the refrigerator instead of using the microwave.
- If you have a manual defrost freezer, keep the ice coating less than 1/4 inch for the most efficient operation.
- Turn off, empty, clean and leave the refrigerator door open when taking an extended vacation.
- Freezers operate most efficiently when they are at least 2/3 full.

Selecting a Washing Machine and Dryer

Like dishwashers, most of the energy used by washing machines is for heating water. Water heating accounts for about 90 percent of total energy use. Most washing machines use from 30 to 40 gallons of water for a complete wash cycle. The energy savings for reducing the water temperature are significant.

Model-to-model, the operation of dryers is very similar. The big choice is which type of fuel – electric or gas. In terms of energy use, gas dryers are less expensive to operate. Electronic ignition is now required for all new gas dryers.

1. Shop around using the EnergyGuide labels.
2. Choose controls that allow you to select various water levels and water temperatures.
3. Consider a suds-saver feature (you can re-use wash water for additional loads).
4. Compare models for water usage, and buy the model with the lowest water usage in your price range.
5. Faster spin speeds can result in more water extraction and reduce drying time.
6. Front-loading (horizontal axis) machines use a third less water and have better washing performance.

Operating Hints

WASHER

- The major cost of washing clothes is for heating water. Wash in cold or warm/cold cycles to save energy.
- Adjust the water level to match the size of the load.
- Always use a cold-water rinse.

DRYER

- Use a clothes line when possible; after drying, tumble in the dryer on air setting, to soften towels and clothes.
- Clean the lint filter after every load.
- Use the washer’s “sturdy clothes” spin cycle to remove as much water as possible before transferring clothes to the dryer.
- Avoid over-drying.
- Use a tight-sealing dryer vent hood that blocks air infiltration.
- Vent the dryer to the outside.

Selecting a Dishwasher

Look for these energy-saving features when buying a new dishwasher:

1. An “air dry” selector. The heat is automatically shut off during the dry cycle. This can save up to 30 percent of the electricity used by your dishwasher.
2. Short-cycle selectors. Use these cycles for lightly-soiled dishes as they use less hot water.
3. Less hot water usage. Dishwashers vary as to the number of gallons of hot water used per cycle. Approximately 80 percent of the energy used by a dishwasher is for heating the water; therefore, look for a model that uses less water – between 8 and 14 gallons for a complete cycle.
4. Look for the yellow EnergyGuide label that should be on all dishwashers. This label will tell you the estimated yearly cost of operation for that particular model.
5. Built-in water heaters. Some energy-conserving models have built-in water heaters that bring the water temperature up to the recommended level of 140°F. If you have this feature, the central water heater temperature can be lowered. For each 10°F reduction in your water heater temperature setting, you cut energy consumption by 3 percent to 5 percent.

Operating Hints

- Dishwashers use an average of 5.8 fewer gallons of water per load than washing the same dishes by hand.
- Wash only full loads.
- Avoid pre-rinsing by scraping off large food particles.
- Match the cycle to the degree of soil.

APPLIANCE AND EQUIPMENT COST OF OPERATION

Comfort	Usage	Cost in Dollars
Air Cleaner	1/20 kWh/hour	$0.004
Air Conditioner, Central		
(36,000 Btu, SEER 7)	5 kWh/hour	0.365
(36,000 Btu, SEER 10)	3 2/3 kWh/hour	0.268
(36,000 Btu. SEER 12)	3 kWh/hour	0.219
Air Conditioner, Room		
(12,000 Btu, SEER 8)	1 1/2 kWh/hour	0.110
Electric Blanket	3/4 kWh/hour	0.055
Fan, Whole House	2/5 kWh/hour	0.029
Ceiling Fan	1/10 kWh/hour	0.007
Oscillating Fan	1/10 kWh/hour	0.007
Box or Window Fan	1/5 kWh/hour	0.015
Heat Lamp	1/4 kWh/hour	0.018
Heating Pad	1/3 kWh/hour	0.024
Fireplace Log, Gas, 33,000 Btu	1/3 therm/hour	0.178
Pilot Usage	1/5 therm/day	0.107
Floor or Wall Heater	1/3 Therm/hour	0.178
Furnace, Forced Air, Gas	1/2 kWh/hour+1Therm/Hour	0.572
Pilot Usage	6 Therm/month	3.210
Portable Heater, Electric, 1,500 watt	1 1/2 kWh/hour	0.110
Vaporizer, Steam	1/2 kWh/hour	0.037
Cool Mist	1/20 kWh/hour	0.004
Waterbed Heater	4 kWh/hour	0.292
Entertainment		
Compact Disc Player	1/10 kWh/hour	0.007
Kiln	30 kWh/firing	2.190
Radio	1/2 kWh/hour	0.037
Sewing Machine	1/10 kWh/hour	0.007
Swimming Pool Filter Pump		
(3/4 HP)	1 kWh/hour	0.073
Swimming Pool Heater	2 1/2 Therms/hour	1.338
Pilot Usage	1/4 Therm/day	0.134
Hot Tub	5 kWh/hour	0.365
TV, Black and White	1/20 kWh/hour	0.004
TV, Color	1/5 kWh/hour	0.015
(Instant-on Feature)	43 kWh/month	3.179
VCR	1/2 kWh/hour	0.037
Computer (PC)		
Monitor (Color)	1/10 kWh/hour	0.007
Central Processing Unit	1/5 kWh/hour	0.015
Printer	1/5 kWh/hour	0.015

APPLIANCE AND EQUIPMENT COST OF OPERATION

Grooming	Usage	Cost in Dollars
Curling Iron	1/100 kWh/use	$0.001
Hair Curlers	1/10 kWh/use	0.007
Hair Dryer	1/4 kWh/use	0.018
Lighted Mirror	1/20 kWh/use	0.004
Shaving, Electric Razor	1 1/2 kWh/year	0.110
Elect. Water Heater, Blade Shave	1 kWh/shave	0.073
Gas Water Heater, Blade Shave	1/20 Therm/shave	0.027
Sun Lamp	2/5 kWh/hour	0.029
Toothbrush with Charger	10 kWh/year	0.730
Household Items		
Clock	1 1/2 kWh/month	0.110
Dehumidifier	1/2 kWh/hour	0.037
Floor Polisher	1/3 kWh/hour	0.024
Heat Tape (10 ft.)	1/20 kWh/hour	0.004
Humidifier	1/10 kWh/hour	0.007
Sump Pump	1 kWh/hour	0.073
Vacuum Cleaner	2/3 kWh/hour	0.049
Well Pump	3 kWh/day	0.219
Laundry		
Clothes Dryer, Electric	3 kWh/load	0.219
Clothes Dryer, Gas	(1/4 Therm+1/6 kWh)/load	0.146
Steam Iron	1 kWh/hour	0.073
Washing Machine, Cold Water	1/4 kWh/load	0.018
Electricity for Hot Water	6 kWh/load	0.438
Gas for Hot Water	1/3 Therm/load	0.178
Water Heater, Electric	13 kWh/day	0.949
Water Heater, Gas	1 Therm/day	0.535
Pilot Usage	3 Therms/month	1.605
Lighting		
Christmas Lights (50 Mini)	1/50 kWh/hour	0.001
Gas Yard Light (Single Mantle)	1/2 Therm/day	0.268
General Household	3 kWh/day	0.219
Mercury Vapor Light (150 watt)(10 hr night)	1 1/2 kWh/night	0.110
Night Light (7 watt)	2 1/2 kWh/month	0.183
Single Bulb (100 watt)	1/10 kWh/hour	0.007

APPLIANCE AND EQUIPMENT COST OF OPERATION

Food Storage and Preparation	Usage	Cost in Dollars
Barbecue Grill (Gas)	1/4 Therm/hour	$0.134
Broiler (Portable Electric)	1 1/2 kWh/hour	0.110
Can Opener	1/3 kWh/100 cans	0.024
Coffee Maker	1/5 kWh/brew	0.015
Corn Popper	1/10 kWh/use	0.007
Deep Fryer	1 kWh/use	0.073
Dishwasher	1kWh/load	0.073
Electricity for Hot Water	3 kWh/load	0.219
Gas for Hot Water	1/6 Therm/load	0.089
Electric Skillet	1 1/2 kWh/hour	0.110
Freezer, Frostless		
15 cu ft Upright	5 kWh/day	0.365
15 cu ft Upright*	3 kWh/day	0.219
15 cu ft Chest Type	4 kWh/day	0.292
15 cu ft Chest Type*	2 1/2 kWh/day	0.183
15 cu ft Manual Defrost	3 kWh/day	0.219
Garbage Disposal	1/100 kWh/load	0.001
Ice Cream Freezer	1/10 kWh/use	0.007
Mixer	1/10 kWh/hour	0.007
Microwave Oven	1/10 kWh/10 min.	0.007
Oven, Electric	1 kWh/hour	0.073
Self Cleaning Feature	6 kWh/clean	0.438
Oven, Gas	1/10 Therm/hour	0.054
Self Cleaning Feature	1/2 Therm/clean	0.268
Range, Electric - Surface Unit	1 kWh/hour	0.073
Range, Gas - Surface Unit	1/20 Therm/hour	0.027
2 Pilot Lights	5 Therms/month	2.675
Refrigerator, Frostless		
16 cu ft	5 kWh/day	0.365
16 cu ft*	2 1/2 kWh/day	0.183
23 cu ft Side-by-Side	10 kWh/day	0.730
23 cu ft Side-by-Side*	4 kWh/day	0.292
10 cu ft Manual Defrost	2 kWh/day	0.146
Slow Cooker	1 kWh/5 hrs.	0.073
Toaster	1/20 kWh/use	0.004
Toaster Oven	1/2 kWh/hour	0.037
Waffle Iron	1/3 kWh/use	0.024
Water Distiller	3 kWh/gallon	0.219

*Post 1990 Energy-Efficient Models.

The estimated usage and costs are average figures. They do not apply to any particular installation or manufacturer's product and vary depending on individual operation. One kWh/hour is 1,000 watts of electricity used for one hour, such as ten 100-watt lamps turned on for one hour. One kWh is equivalent to 3,412 Btus (British Thermal Units) of heat energy. One therm of natural gas, when burned, will produce 100,000 Btus of heat energy. One Btu is nearly equal to the heat produced by burning one standard kitchen match.

The typical energy costs were computed using $.073 per kWh for electricity, $.535 per therm for natural gas and $.687 per gallon for propane gas. The table may be used for evaluating the relative operating costs of various appliances. Any cost totals from the above table should be corrected using your actual fuel costs.

Sources: Association of Home Appliance Manufacturers and Pacific Gas and Electric

Heating is the largest energy expense in most homes. Reducing the energy used for heating is the single most effective way to reduce the utility bill.

A combination of conservation efforts and a new, high-efficiency heating system can cut fuel bills in half without lowering your comfort level.

The heating system replaces heat that is lost through the envelope of the house. How much heat is needed depends on how big the house is, how cold and windy the winter is, the efficiency of the house, the efficiency of the heating system and the habits of the family.

If there is a choice of heating fuels, the decision is generally based on economy of operation. The cost of operation is not only based on the fuel cost but the efficiency of the heating system. Other factors that should be considered are the system cost and the cost of fuel delivery (installing natural gas mains).

Forced-air Systems (Gas-fired)

Forced-air furnaces that deliver heated air to all parts of the home operate from a thermostat that signals burners to ignite. When the air surrounding the heat exchanger in the plenum reaches a preset level, the electric-powered blower comes on. Air from inside the house is pulled into the furnace cabinet through the return air duct. The air passes through a filter and is circulated over the outside surface of the heat exchanger. The heat is transferred to this circulated air through the heat exchanger walls and does not come in contact with the fuel or the products of combustion. A blower forces the heated air circulating around the heat exchanger out of the furnace, through the ductwork, out the registers and into the living space. Return air ducts carry the cooler room air back to the furnace where it is reheated. Both delivery and return air ducts should be well sealed and insulated where they pass through unheated areas.

When the desired room temperature is reached, the thermostat signals the burners to shut off. The blower continues to operate until the furnace cools to a preset level and then shuts off. The plenum thermostat that controls the blower can be set to come on at a lower temperature and stay on longer to move more heat into the home.

It is very important with forced-air systems to clean or change the filters monthly during the heating and cooling season. Older, natural gas forced-air systems have a continuously burning pilot to ignite the gas-air mixture. New, high-efficiency furnaces have electronic ignition devices.

It is not a good idea to spend money for repairs on an older furnace. Existing forced-air furnaces have a seasonal efficiency of about 60 percent; new systems have a seasonal efficiency of 80 percent to 95 percent. Changing an older system to a new, high-efficiency system, instead of investing in repairs, should be done; however, replacing a working furnace with a new high-efficiency model has a long pay-back time.

Hydronic Systems

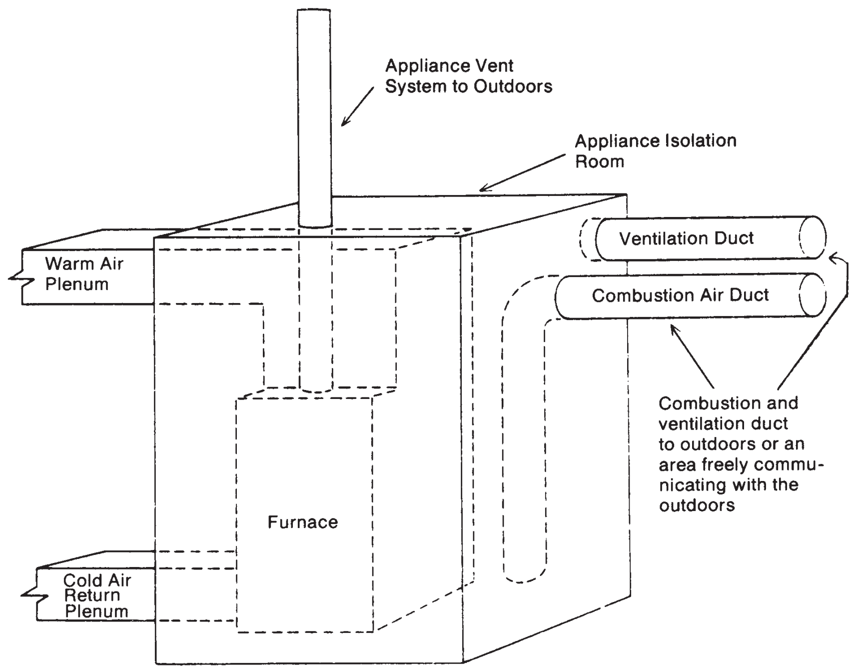
Hydronic (hot water boiler) systems are less common. In this system, hot water from the boiler is circulated through pipes to radiators in each room, then back to the boiler to be reheated. There is a pump at the boiler which circulates the hot water from the boiler to the radiator. The thermostat usually controls the pump and burner and turns it on when the house needs heat. The water starts circulating and continues until the thermostat setting is reached.

This type of heating system is a radiant system and does not have fans, which eliminates the chilling factor of moving air. The system is more efficient because it does not have duct losses. For more efficient operation, a control can be added to measure outside temperature and adjust the boiler temperature hotter as the outside temperature cools. Boilers can be fueled by gas, electricity or even wood.

Combustion Air

The need for combustion air for gas-fired heating appliances must not be overlooked. Failure to provide adequate combustion air will ultimately result in the production of carbon monoxide. Overall tightening of a dwelling could make a home so tight that adequate combustion air would not be provided to the gas-fired appliance.

This illustration provides a rather simple method of providing combustion air to gas-burning heating appliances.



If your furnace draws combustion air from the crawl space, and you seal and insulate the crawl space, you need to be sure adequate combustion air is provided by running a combustion air duct from a crawl space opening to the furnace.

Replacement Systems

When your existing gas furnace or boiler fails, you will need to replace it. There are a number of replacement furnaces to choose from, including many high-efficiency models. Over the lifetime of the heating system, the pay-back in energy savings can be substantial.

How do you know which one to buy? First of all, check all the models available before you decide. We suggest getting bids from several contractors.

EnergyGuide fact sheets are available from your heating contractor or dealer. These fact sheets will help you compare models. Be sure to ask the heating contractor who replaces your furnace to run a heat loss calculation on your home. This is needed to size the new unit correctly. A new furnace will probably have a lower Btu input rating.

If you replace your furnace, you will usually need a permit from the local building authority. Also, any time you have work done on your furnace by a contractor, be sure he/she is licensed and has taken out all of the necessary permits, if applicable.

It is seldom cost-effective to replace a working, existing furnace. The exception is an old coal stoker that has been converted to natural gas. It should be replaced as soon as possible.

Electric Heating Systems

Electricity is a more expensive fuel than natural gas, so it is important to choose the most efficient electric heating system you can afford.

Forced-air electric furnaces, employing resistance heating coils, are sometimes used in small homes and apartments because they are less expensive up front, however, they cost more than twice as much to operate as electric heat pumps.

Baseboard resistance heaters use a metal element to convert electricity to heat. Almost all of the electricity that passes through the element is converted to heat.

The units are located in each room and usually have individual thermostats. By zone-heating, keeping only the room you are using at a higher temperature, this type of heating cost can be reasonable.

Radiant panel heating may be located in the floor, walls or ceiling and may use electric resistance heating or hot water from a central boiler. The heat is transferred by radiation and convection to the surrounding room.

If the radiant heating is located in the ceiling or floor, be sure the attic or foundation is adequately insulated. By the same token, walls should be insulated behind the radiant panels to keep the heat inside the home. Radiant panel systems can be slow to respond to temperature changes.

Heat Pumps

Electric heat pumps have been available for home heating for more than thirty years. Essentially an air conditioner running in reverse, heat pumps produce two to three units of heat energy for each unit of electrical energy consumed. A seasonal efficiency rating for heat pumps has been devised by the U.S. Department of Energy (DOE). This rating, known as the Heating Season Performance Factor (HSPF), equals the average heating capacity in Btu-per-hour divided by the power consumption in watts. The efficiency of a heat pump increases with higher outdoor temperatures, therefore, seasonal efficiencies are higher in warmer climates.

Most heat pumps employ the same basic layout and components as the equipment of 30 years ago. With the emphasis in the last decade on energy efficiency, and with the advent of solid state controls, today's heat pump offers marked improvements in efficiency and reliability. Because heat pumps also provide cooling in summer, consideration should also be given to their cooling-efficiency rating or Seasonal Energy Efficiency Ratio (SEER). New developments in heat pumps, including variable speed compressors and new compressor designs, are improving the HSPFs.

Air-to-air heat pumps are effective in winter at temperatures down to about 30°F. Supplemental heat is necessary at temperatures below that.

Ground source heat pumps are the most efficient and most expensive in initial cost of electric heating systems. These units use the ground, or ground water, as a heat source for warming, or a heat sink for cooling. Generally, ground source heat pumps are installed at the time of construction or when retrofitting an existing air-to-air system.

Living with a Heat Pump

The heat pump delivers air at temperatures closer to room temperatures than conventional gas or electric furnaces. Because a heat pump does not deliver hot blasts of air, some people will feel cool until they adjust to a heat pump-conditioned environment.

The effectiveness of a heat pump is diminished by closing off unused rooms. Thus, the homeowner must heat all of the home instead of only rooms used on a constant basis.

Special automatic thermostats must be purchased if you want to set back temperatures at night and during periods the home is unoccupied. Without the special thermostat, the immediate several degree jump in the heating when the thermostat is turned up requires the backup heat source (usually electric resistance heating), so the heat pump savings are reduced.

If you are replacing an existing system with a heat pump, be sure to ask the contractor if your present ductwork will have to be modified or replaced. Heat pumps require large ducts, and there should be several air returns. Both ducts and returns should be insulated in all systems.

Leaky ducts are a serious problem in homes that use forced-air heating and air conditioning.

Distribution losses amount to 5 percent to 30 percent of the fuel consumed.

Duct sealing yields the biggest savings when the ducts are located in an unconditioned area that is well connected to the outdoors. The outdoor air enters the return duct leaks, and heated or cooled air exits the supply ducts. This leakage wastes energy. It also pressurizes and depressurizes areas of the home, providing a driving force for air leakage throughout the building shell. When ducts are located in conditioned areas, duct leakage leads to some inefficiency and local temperature differences, but isn't a major energy problem. Return leaks are the trickiest to find and the most important ones to seal, especially return leaks near the furnace. It is very important for the safety of the residents to seal ducts thoroughly and to relieve pressure problems near combustion furnaces. A large return-air leak near the furnace can draw flue gases down the chimney into the living space.

Duct Sealing

Duct sealing is an extremely important and often neglected energy management measure. The forced-air supply and return ducts should be an airtight, closed system joining the furnace to the building. Duct joints should be sealed with duct mastic between the furnace and ducts, between registers and floor, wall, or ceiling, and between duct sections.

Duct Insulation

Fiberglass is the most common insulation for ducts. Seams should be tight between pieces of insulation.

It is important to avoid insulation gaps and voids. The insulation should wrap all the way around the duct. Seal the seams with a high-quality tape. Metal fasteners hold insulation in place better than tape. Fiberglass duct board and insulated flexduct are duct materials with built-in insulation. They are not as durable as metal ducts but are easier to build and install. Duct board and flexduct ducts must have a larger cross-sectional area compared to metal ducts, because they are rougher inside and therefore create more air resistance. Flexducts should not be used for long runs.

Hot water or steam pipes should also be insulated.

Conservation Devices

The number of "energy-conservation devices" for gas or electric heating systems on the market is growing rapidly. Many of these devices are well constructed and, if properly installed, are safe.

All of these devices (except some automatic clock thermostats) should be installed by a qualified heating contractor; they are not designed to be installed by the do-it-yourselfer.

Thermostats

Temporary day or night set-back (turning the temperature down at night or when no one is at home) will save about 1 percent per degree of eight-hour set-back. **Note**: A thermostat should not be located by a direct source of heat (i.e. heating vent, lamp, stereo, television or sunlight), on an outside wall or under a whole-house fan opening.

Permanent set-back (setting the thermostat temperature back to a lower setting and leaving it there) will always save energy. There are some drawbacks to extreme set-back. Elderly individuals and those with poor health should not set the thermostat down below 68°F. Hypothermia, a lowering of body temperature and slow-down of bodily functions, could result if the temperature is too low.

Set the temperature as low as you can to still be comfortable. Don't forget to add additional layers of clothing so you can be comfortable at lower temperatures.

The savings potential is very different between permanent and temporary set-back. For permanent set-back, there is a potential energy savings of about three percent per degree of set-back.

Clock thermostats will save energy by automatically turning the thermostat down and up on a preset schedule. An advantage is that your home will be warm when you get up or come home. But, if you can train yourself to manually turn the thermostat down, you can save the same amount of energy.

A special type of set-back thermostat is necessary for use with heat pumps.

Vent Damper

The vent damper is a device that automatically seals the combustion flue gas vent during the off cycle of the gas furnace. This saves energy by preventing room air from going up the vent while the furnace is off.

The effectiveness of a vent damper varies greatly and should only be installed by a qualified service person. An automatic vent damper is only effective when installed on heating equipment located in a heated area, such as a utility room or heated basement. Make sure the type you use is certified and approved for installation in your area.

A vent damper is standard equipment on new furnaces. Before installing a vent damper on an existing furnace, you should evaluate replacing an older furnace.

Intermittent Ignition Devices (IID)

An intermittent ignition device eliminates the use of a constantly-burning pilot light by electrically igniting the gas pilot each time the furnace is called upon to operate. If the pilot does not ignite, the ignition control will not allow gas to flow to the main burner. IIDs are normally cost-effective on new systems. At present energy costs, however, it is not usually economical to add to an existing furnace. An IID is standard equipment on new furnaces.

There are several reasons you might choose to use a space heater: If you have a cold area in your home, if you want one area to be noticeably warmer than the rest of the home or if you are trying to save energy.

If you turn your central heating system down a few degrees and supplement the heat in a small area with a space heater, you will probably save money. If you do not turn the thermostat down and add more heat with the electric space heater, you will probably increase your total bill.

Electric Heaters

Most electric heaters have several settings. They range from the 500 watt setting, which costs about 2 cents for every hour of operation, to the 1,500 watt setting which costs 7 cents per hour of operation. Larger electric heaters are available but require special wiring.

Efficiency

All electric resistance heaters are considered 100 percent efficient and convert electricity into heat at the rate of 3,412 Btus per kilowatt hour (kWh). Some heaters deliver heat more efficiently.

For constant usage, a radiator-type heater provides even warmth. Free-standing or wall-hung units provide a safe source of heat for limited areas. A good application would be a nursery or any room in constant use that you want to maintain slightly warmer than the rest of the house. This would not be a good choice for quick warm-ups. The surface of this type heater will not become hot enough to burn.

For heating an area quickly, a **convection** heater with a ribbon or wire heating element is best. These may be free-standing or wall-hung. A fan will help move the heat away from the heat source. Uses for these heaters would be in bathrooms, workshops and seldom-used areas.

For spot heating, a radiant heater will warm objects or people in its path. They provide warmth almost instantly to objects, but are slow in heating a room. Examples of usage for this type heater would be for a person at a workbench, in a chair or at a sewing machine.

It is a good idea to buy a heater with a thermostat.

Safety

Always follow manufacturers' directions. Contact with the heating element in an electric heater can cause fabric to catch fire or can burn the skin. Heaters with enclosed elements (radiator-type) have lower surface temperatures. Never touch an electric heater while taking a bath or shower, or while touching a faucet or water pipe.

You can use a 1,500 watt heater on a circuit with at least a 15 amp fuse or breaker with no other appliance on that circuit. If a fuse blows or breaker trips, you have overloaded that circuit and need to contact your electrician. ***Never use an electric heater with a common household extension cord.***

Fireplaces

Gas-fired fireplaces have an efficiency of 70 percent and can actually heat a house. They have their own combustion air and can be thermostatically controlled.

Wood-burning fireplaces may waste energy and raise a utility bill. A standard fireplace is usually 10 percent or less efficient and should not be used when the outside temperature is below 20°F. Fireplaces have huge combustion requirements, 250 to 400 cubic feet per minute according to most estimates. If the fireplace doesn't have its own dedicated supply of air, it uses household air you have paid to heat. As this air rises up the chimney, infiltration increases. Much of the heat lost in using a fireplace occurs after the main fire, when the damper must be left open for burning embers. This heat loss can be reduced by installing tight-fitting glass doors.

Gas logs are pretty to look at but do not add significant amounts of heat to the house. They also require combustion air, which increases infiltration, causes heat loss to the home and raises a utility bill.

If you are building a home and plan to have a fireplace, consider locating the fireplace on an interior wall. It should also have a duct to provide outside combustion air. If heating with wood is the main objective, consider a wood stove or fireplace insert. Wood stoves have efficiencies of 60 percent.

R-Value … What is It?

R-value tells you how well a material resists heat flow. The higher the R-value, the greater the resistance. R-values per inch vary with different types of materials. Therefore, how well insulation performs is more accurately measured by its total R-value than by inches of thickness.

Recommended R-Value

Recommended minimum R-Values for a Missouri home:

Ceiling:	R-38
Walls:	
2x4	R-13*
2x6	R-19
Floors:	R-19
Crawlspace walls:	R-10

* An additional R-3 or more of exterior insulated sheathing will provide improved comfort and will be cost-effective in some applications.

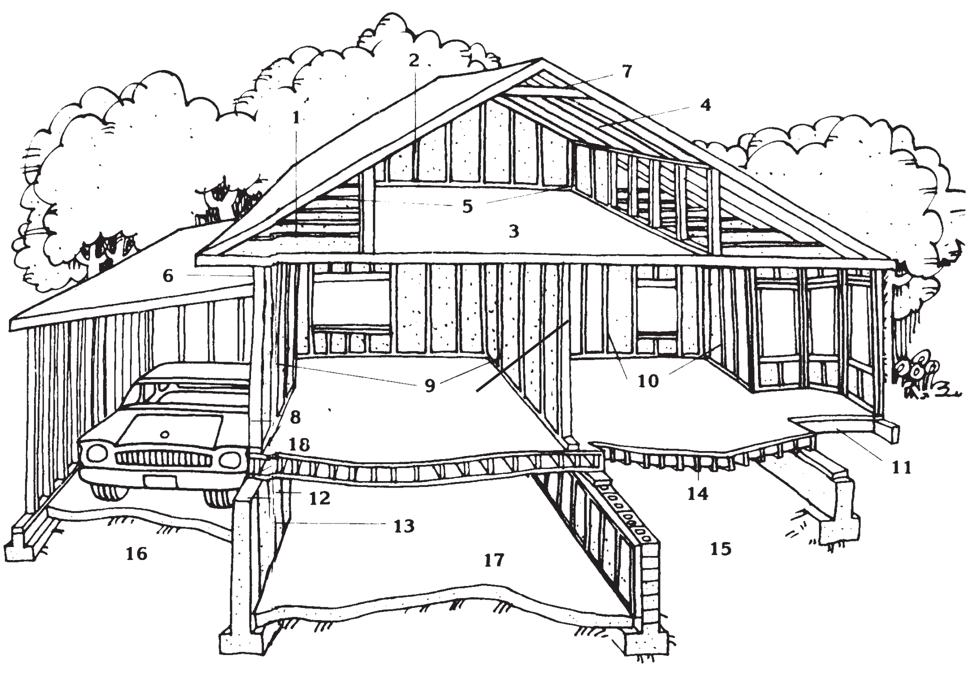
Where to Insulate

Insulation should be between any area that separates a heated space from an unheated space. This includes all exterior walls, attics, floors over unheated areas, heated basement walls and overhangs. Other areas that should not be overlooked include exterior walls between levels in a split-level home, rim joist area, knee walls next to unheated garages, storage rooms, utility rooms, dormer and cantilever walls and ceilings, and floors over vented crawl spaces.

In other words, the insulation should completely surround your home with the only openings being doors, windows and vents.

Places to Insulate

1. ceiling joists
2. finished attic end walls
3. attic living space
4. rafters to knee wall in finished attic
5. finished attic knee wall exposed to cold
6. short exterior walls
7. finished attic collar beams
8. wall to unheated garage
9. interior wall can be insulated for sound proofing
10. all exterior walls
11. cantilever area
12. sill
13. heated basement walls
14. under floor
15. open crawl space
16. under slab
17. rim joist



Safety

1. Provide good lighting.
2. Be careful of any protruding nails.
3. Wear protective equipment.
4. Provide adequate ventilation.
5. Keep lights and all wires off wet ground.
6. Use temporary flooring to form a walkway in unfinished attics (the ceiling won't support your weight).
7. Don't move wiring around. If you find brittle wiring, leave it alone and call an electrician.

Vapor Barriers

A vapor barrier should be placed on the "warm-in-winter" side of the insulation. Face the vapor barrier down when insulating between ceiling rafters, on the inner (room) side of exterior walls and up when insulating floors. Do not install a vapor barrier on top of existing attic insulation.

You might note that, although a vapor barrier will protect insulation and building materials, it will also increase the humidity level in your home. The amount of moisture or the humidity level in your home will depend on a number of factors. Such factors include the amount of air leakage that occurs in your home, the amount of insulation, whether or not you use a humidifier, the number of household members, the amount of cooking, showers, washing and drying clothes and whether you have a large number of plants (see chart, page 30). Any tears or cuts in a vapor barrier should be repaired with tape to protect the effectiveness of the barrier.

Be Careful When Installing Insulation

Excessive moisture in the home filters through insulation, causes it to become damp and matted, and makes it lose much of its effectiveness.

To prevent or reduce condensation problems, the side of the insulation exposed to high vapor pressure (warm side in winter) must be covered with material that will impede the natural drive of moisture to flow through the inside surfaces of exterior walls, toward the lower vapor pressure outside. To be effective, such a material must have a high resistance to moisture flow. The material is usually called "vapor barrier" or "vapor retarder" (see illustrations, page 24).

If moisture problems exist, you may have to increase ventilation in your home by using such items as exhaust fans or air-to-air heat exchangers. Please note that these options use energy to operate. So, in terms of conserving energy, it is wiser to try to reduce the source of humidity by following the suggestions outlined in the section on moisture considerations and control in this book (page 30).

Preparing the Attic

There are several things you need to do to most types of attics to prepare them for insulation:

1. If your roof has leaks, fix them! Look for water stains, find the leaks, and repair them.
2. Inspect for adequate ventilation (see section on Attic Ventilation for requirements, page 31).
3. Cover open chases or holes in the attic as necessary to prevent insulation from falling through.
4. Cover dropped soffits over kitchen or bathroom cabinets, open interior wall cavities, dropped ceilings and stair wells before insulating. Gaps in insulation may tremendously reduce the overall effectiveness of the insulation.
5. Chink or stuff scraps of insulation around fireplace chimney and end walls.
6. Always keep insulation at least three inches away from the sides of recessed light fixtures, fluorescent light fixtures, wiring compartments and fluorescent light ballasts. Use a fire-proof baffle to keep the insulation away from the fixture when using loose fill.
7. Use a baffle to prevent insulation from blocking air flow from the eave or soffit vents into the attic.
8. Be sure the insulation extends far enough to cover the top plate on outside walls.
9. It is not necessary to insulate above unheated areas such as a porch or patio. It may be helpful to mark and block off these areas.

There are different methods of insulating different types of attics. Take a look at the following information to determine your attic type and the type of insulation recommended.

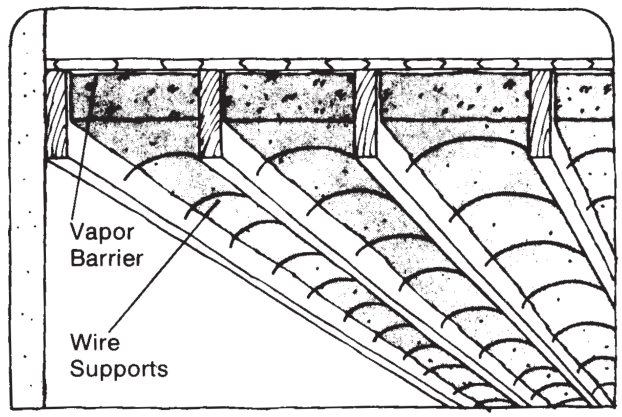
Attic Types	*Insulation Options*
Open, unfinished, unfloored, unheated	Batts, blankets, wet-blown cellulose, or loose fill can be placed between ceiling joists. Loose fill or wet-blown can be added on top of existing insulation. A second ply of batt insulation should be unfaced and laid perpendicular to the first ply.
Unfinished, floored	Loose fill can be blown under the floor between ceiling joists. If the attic will ever be heated or used as living space, insulate with batts, blanket, or wet-blown between roof rafters and on end walls.
Heated, used as living space	Use batts, blankets, or wet-blown on vertical kneewalls. Blow or pour in loose fill between ceiling joists and outer attic rafters behind kneewalls. Stuff rafter cavity above the kneewall and blow insulation down the rafter cavity.
Cathedral ceiling	The most common practice is to blow in loose fill or wet-blown insulation if you are insulating the ceiling where there is a cavity. If there is no cavity, rigid insulation may be applied on the interior surface and caulked.
Flat roof	Same as cathedral ceiling.

Insulating **crawl spaces** can be done by insulating either the perimeter (foundation) wall or by insulating beneath the floor. If you choose to insulate at the floor level, you must also insulate ducts and water pipes. It generally takes less material to insulate the foundation wall instead of the floor, ducts and water pipes.

Insulating at the floor level allows for ventilation and a supply of air to the furnace if it is located within the house. Areas over unheated basements, garages, porches and crawl spaces should be insulated.

Floor Insulation

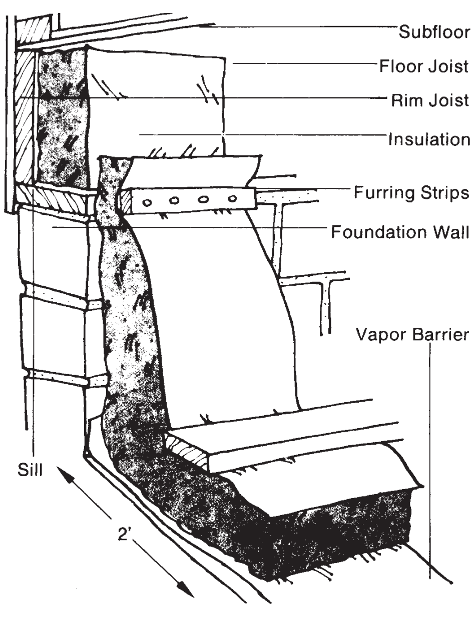
Six-inch fiberglass (R-19) is recommended in Missouri. With the exception of garages, the floor joists are spaced every 16 inches or 24 inches. You can purchase standard width batts or blankets; otherwise, you will have to do some cutting and fitting.



If you are insulating the floor over an unheated dirt crawl space, lay six-mil plastic (polyethylene) on the ground to keep moisture from being drawn up into the house. The ground may feel dry, but moisture is drawn up during the winter. Extend the plastic sheet several inches up the walls and fasten in place with tape. Overlap adjoining pieces, and anchor with bricks, rocks or sand.

Cut batt or blanket insulation to fit between the joists, allowing about an extra inch in width so the insulation will fit snugly. Use insulation with a vapor barrier and install it with the vapor barrier face up.

Support the insulation with wire supports to keep the batt up against the floor (see illustration). Don't block combustion air openings for furnaces if there are any, and don't block the vents into the crawl space.



Perimeter or Foundation Insulation

Using R-11 batts, cut strips of insulation the length of the crawl space walls plus two feet. Beginning where the joists run at right angles to the wall, press pieces of insulation, vapor barrier side toward you, against the header – they should fit snugly. Then install the wall and perimeter insulation by nailing the top of each strip to the sill using 1/2" X 1-1/2" long nailers. Make sure the batts fit snugly against each other and that the vapor barrier side is toward you. They should be long enough to extend two feet onto the crawl space floor.

Where the joists run parallel to the wall, install the insulation by nailing the top of each strip to the band joist, using the long nailers.

When all the batts have been installed, lay down a 6 mil polyethylene vapor barrier to contain the moisture in the dirt floor. Tuck the vapor barrier under the batts all the way to the foundation wall. Tape the joints of the vapor barrier or lap them at least 6 inches. Finally, place bricks or rocks along the wall on top of the batts to keep them in place.

R-VALUES OF MATERIALS

Building Material	Thickness in Inches	R-Value
Plastic Film	-	negligible
Building Paper	-	negligible
Gypsum or Plaster Board	3/8	0.3
Concrete, Sand-gravel	4	0.3
Plywood	1/2	0.6
Oak, Maple and Similar Hardwoods	1	0.9
Concrete Block, Sand-gravel	8	1.1
Fir, Pine, and Similar Softwoods	1	1.3
Hardboard	1	1.4

Sidings	Thickness in Inches	R-Value
Vinyl, Steel or Aluminum	-	negligible
Stucco	-	0.2
Asbestos Shingles or Siding	-	0.2
Stone Facing	4	0.3
Brick Facing	4	0.4
Wood	1/2	0.9

Interior Materials	Thickness in Inches	R-Value
Linoleum or Tile	1/8	0.01
Terrazzo	1/8	0.1
Hardwood Flooring	1/4	0.7
Carpet and Rubber Pad	-	1.2
Carpet and Fibrous Pad	-	2.1

Other Insulation Materials	Thickness in Inches	R-Value
Expanded Vermiculite	1	2.1
Blown-in Fiberglass	1	2.3
Mineral “Rock Wool”	1	2.7
Fiberglass Batts	1	3.0
Expanded Polystyrene (Bead Board)	1	3.6
Blown-in Cellulose	1	3.7
Ureaformaldehyde Foam	1	4.5
Extruded Polystyrene (Styrofoam)	1	5.4
Poly Isocyanurate	1	8.0

Unfinished Walls

If your walls are accessible, you will be able to install insulation in unfinished walls yourself. Don't forget to follow safety procedures.

Use batt, blanket or wet-blown insulation in the walls. When installing insulation with an attached vapor barrier, the barrier should face the side of the wall that is warm in winter. The insulation should fit snugly against the top and bottom framing members and between the studs.

If you use faced batts, staple the flanges on each side of the batts to the studs, compressing the batts as little as possible. We recommend that you use unfaced friction-fit batts or blankets and cover the entire face of the wall on the "heated-in-winter" side with a separate vapor barrier. This technique usually produces a better vapor barrier.

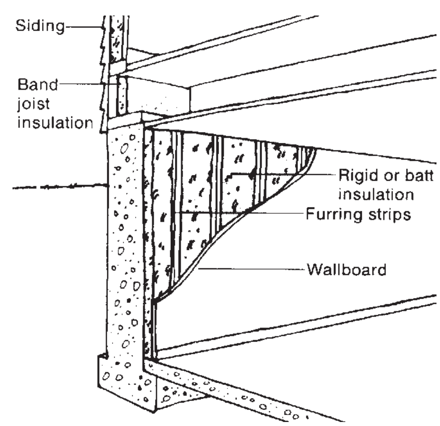
Install insulation behind the cold side of electrical outlets and switch boxes and around water pipes to keep them from freezing. Batts can be split to allow for pipes and wiring. Flammable materials must be kept back from flues, chimneys, electrical fans and other heat-producing equipment. Also, carefully fit the vapor barrier around outlets. Patch any rips or tears with tape and cover the vapor barrier with gypsum wallboard or suitable fire-resistant paneling.

Don't forget to add electrical outlet gaskets behind your switch plates and outlets on outside walls and inside walls. You can find these outlet gaskets at your local hardware stores, lumber yards or energy conservation centers.

Basement and Masonry Walls

Before insulating, check to see that there is no moisture coming through the basement walls. If there is, eliminate the source of dampness.

Construct a stud framework against the masonry walls. For more information on construction, check for references in your local library. To insulate, follow the same procedure as for unfinished walls. Remember to cover all the insulation with gypsum wallboard or other approved, fire-retardant wall surface material.



Rigid foam board may be used to insulate basement walls and can either be glued or nailed to the concrete before the drywall is put up. If glue is used, be sure it is approved by the manufacturer of the rigid foam board because some types of glue can cause foam board to deteriorate. Code requires that foam board used on the interior of the home be covered by drywall.

If a rigid foam board is used to insulate the exterior of the foundation (either crawl space or basement), make sure it will resist water, or that it is covered with polyethylene sheeting below grade in such a manner that water cannot damage it. Extruded polystyrene ("blue board") and polyisocyanurate will not absorb water, whereas expanded polystyrene ("bead board") will.

Above grade, the foam board should be covered to protect it from deterioration by the sun. If the board is in an area where it may be damaged, it may need to be covered with a harder surface such as siding, stucco, or latex-fortified mortar. Insulating the exterior of a foundation is thermally more efficient than insulating the interior because this allows the concrete to become a heat storage area.

Air Changes

Planting trees and shrubs around your home will help reduce your heating and cooling costs. How much it reduces costs depends on the choice of plants, where you locate them, the location of your home and its construction.

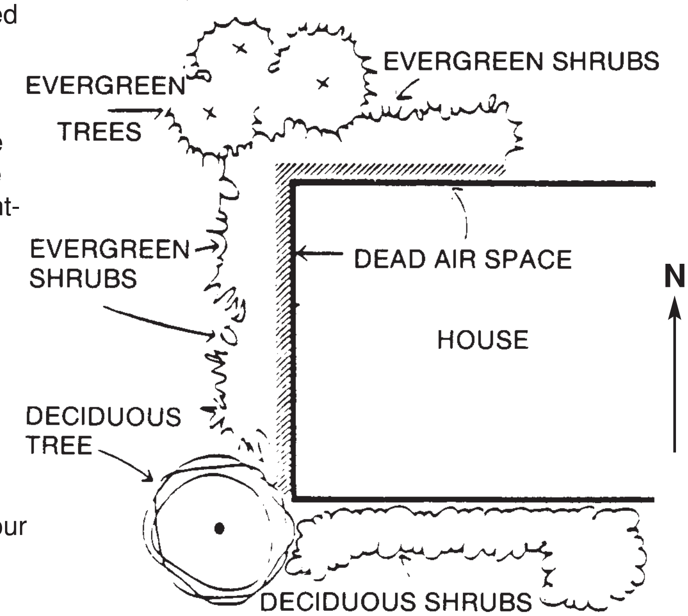
Trees and shrubs also reduce noise and air pollution and make your home more attractive and more valuable. Therefore, money spent on landscaping your home is a good investment.

Winter

An unprotected home loses much more heat on a cold, windy day than on an equally cold, still day. Well-located trees and shrubs can intercept the wind and cut your heat loss. Studies of windbreaks show they can reduce winter fuel consumption by 10 percent or more. Trees and shrubs planted close to a building reduce wind currents that otherwise would chill the outside surfaces. Foundation plantings create a “dead air” space which slows the escape of heat from a building.

Foundation plantings also help reduce air-infiltration losses around the foundation of the house. Closely planted evergreens are suggested for this area.

Deciduous trees lose their leaves in the fall and allow the winter sun to enter the windows and warm the inside space. In the summer, their leaf cover provides cool shade which reduces your home’s need for mechanical air conditioning.



Summer

The maximum air-conditioning need in Missouri is usually in late July and early August, and most electrical power for air conditioning will be used in the late afternoon hours. With this in mind, landscape plantings should include trees and tall shrubs to shade west-facing walls, windows, and the southwest corner of the home during the hottest summer afternoons. Quick-growing vines may be planted on trellises to provide summer shade screens while trees are growing. If there is no roof overhang to significantly reduce the effects of the sun on south walls, deciduous trees and shrubs should also be planted to shade south walls and windows.

When planting trees, choose the site carefully. Plant tall growing trees such as hickory, walnut, oak, pecan, sweetgum and pine well away from any power lines so branches do not tangle in the wires. Avoid planting trees over underground utility lines.

Xeriscape Gardening

Within the Xeriscape landscape, plants are zoned or grouped according to their water needs. Proper plant location is as important as plant selection. Turf is considered a plant, not a filler. Typically, there are three water use zones; low, moderate and high. This, along with mulch and plant selection, avoids the need for excessive water use.

Lighting accounts for only 5 percent to 10 percent of total energy use in most homes.

Incandescent lighting is very inefficient. Much of the electricity used is changed into heat instead of light, which shortens the bulb's life. These bulbs are the most common type used in residential lighting.

Compact fluorescent lighting became available in the early 1980s. It uses just 1/3 as much electricity for the same light as incandescent bulbs and lasts 8 to 12 times longer. Compact fluorescents save money compared to incandescents, but they cost more to buy. Over the life of one compact fluorescent bulb (about 10,000 hours), you can expect a savings of $10 to $15.

Many incandescent bulbs can be replaced with a compact fluorescent bulb. However, because of their larger size, some fixtures cannot be retrofitted. Compact fluorescents have good color rendition and don't flicker or make noise. You may notice some do not light instantly and may be slow starting in cold temperatures. They can be used in three-way fixtures but will operate only on two of the three settings and provide one light level. Compact fluorescents cannot be dimmed.

The best use for compact fluorescents is in lights that are left burning for many hours, such as porch lights or night lights, or where the bulb is difficult to replace, such as over a stairway.

Tube fluorescent lighting has improved dramatically over the past ten years. Fluorescent tubes almost match incandescents in color rendition. Do not be satisfied with standard cool-white or warm-white tubes. Look for products with high color rendition indexes (CIR); also look for high efficiency. A standard four-foot tube can be purchased using only 32 watts instead of 40 watts. Electronic ballasts, instead of magnetic ballasts, totally eliminate hum or flicker. Some of the newest high-efficiency lamps are smaller in diameter and would require new fixtures.

Use tube fluorescents in kitchens, bathrooms, workshops and for indirect lighting. You can buy fixtures that can be dimmed to vary the light levels.

Outdoor lighting is good insurance against vandalism and theft. Mercury vapor lights are still the most common for outdoor lighting, but they are quickly becoming obsolete because of the higher efficiency and improved color quality of high-pressure sodium and metal halide lights.

Using lighting wisely means turning off lights when not needed. Turning off incandescent or fluorescent lights ***will not*** increase usage. There are a large variety of occupancy sensors available. Other ways to control lighting are with time clocks and photovoltaic sensors.

Keep light bulbs, reflectors, shields and lampshades clean. Dust and dirt absorb light, lowering lighting levels as much as 50 percent. Light colors used in decorating will reflect more light than dark colors, so you can use lower intensity bulbs for adequate illumination.

The word “moisture” refers to water vapor mixed with air. Most of the moisture generated in the home is dissipated by the movement of moisture-laden air out of the home. As homes become more energy-efficient, the number of paths of escape are reduced, and dealing with moisture becomes more important.

How Moisture Acts in Your Home

Moisture in your home is not necessarily harmful because the humidity of a home affects your comfort. For example, most people will feel cooler in a room at 75°F and 25 percent relative humidity than in a room at the same temperature with 40 percent relative humidity. It follows then, that in the room with the higher relative humidity level, the occupant will be less likely to raise the thermostat setting in winter because he or she will feel warmer, thus there will be a savings on the heating bill.

Excessive humidity can contribute to a large number of problems ranging from serious building damage to extreme discomfort in hot weather. Building specialists and homeowners need a thorough understanding of the effect of moisture on the home in order to successfully correct or avoid many problems.

High levels of humidity are often the result of too much moisture vapor generated indoors, usually by bathing, cleaning, cooking and water evaporation and emission. If high moisture levels are a problem, they can be reduced by installing (and using) ventilation fans in bathrooms and laundry rooms, covering exposed earth in a crawl space with a vapor barrier, installing downspouts that flow away from the foundation, and, if possible, sloping the grade away from the house. House plants and pilot lights also add moisture to a home.

During the heating season, the indoor humidity level should hover around 30 percent to 40 percent. One symptom of high humidity level is condensation forming on cold surfaces.

A more common winter humidity problem is the too-dry home. A house that is dry will seem colder, and static electric shocks occur. Dryness is a symptom of excessive air infiltration.

During the summer, indoor humidity can be controlled by an air conditioner or a dehumidifier.

Homes that are characterized by one or more of the following conditions are more likely to experience excessive moisture accumulation:

- Less than 800 square feet of total living area.
- Less than 250 square feet of living area per occupant.
- Tight wall and ceiling construction and weatherstripping on windows and doors (low level of infiltration).
- Heating systems which use outside combustion air.
- Low sloped roofs or unventilated attics.
- Cracked heat exchanger in gas space-heating equipment.
- Electrically heated home.
- Unvented appliances.
- Excessive use of a humidifier.

If moisture problems exist, you may have to increase ventilation in your home by using such items as exhaust fans or air-to-air heat exchangers. Please note that these options use energy to operate. So, in terms of conserving energy, it is wiser to try to reduce the source of humidity.

Window Condensation

Condensation problems may indicate that your windows are faulty or that your indoor humidity is too high. Condensation will occur whenever the window surface is cool enough to allow moisture in the air to condense on it, which is why some condensation can be expected in the winter – although condensation should be controlled as much as possible since it can damage the window’s components. Moisture on the inside of the storm window (or outside pane) indicates that the prime window is allowing air and moisture to leak out to the storm window where it condenses. Stopping these air leaks with caulk and weatherstripping will stop the condensation and ultimately save your window. It is also important to understand that too little humidity is bad for your house. Manufacturers claiming that low humidity (15 percent) is best for windows may be covering for a poor quality product. Good windows should not have excessive condensation at normal humidity levels (30 percent to 35 percent).

Steps to Reduce Excessive Humidity

Recognize that the best way to stop condensation is to reduce the moisture in the inside air. Eliminate or reduce any sources of moisture in your home that you can control.

1. Be sure that attic or crawl spaces are properly ventilated. Add a vapor barrier to cover the earth in the crawl space.
2. If you have single-pane windows, install storm panels, double-pane insulating glass or triple-glazed panels.
3. In winter, provide more controlled ways for moist inside air to get out. Run kitchen and bathroom ventilating fans during periods of moisture production.
4. Vent your clothes dryer to the outside.
5. Address water problems such as seepage from the outside, leaks in a roof or walls, and leaky pipes.

Moisture Production

Source	Water Vapor Produced
Human respiration by an average family of four	8 to 12 pounds in 24 hours
Cooking for an average family of four on a gas range	5 pounds per day
Showering	1/2 pound per shower
Tub bath	1/8 pound per bath
Clothes drying	1 pound of water per pound of dry clothes (if dried inside or dryer is not vented)
Living plants	About the same produced in watering the plants
Unvented gas heater (each 100,000 Btus or each therm)	8 to 10 pounds
Humidifier	Nameplate rating of unit

Be Careful When Installing Insulation

Excessive moisture in the home filters through insulation and causes it to become damp and matted and to lose much of its effectiveness.

To prevent or reduce condensation problems, the side of the insulation exposed to high vapor pressure (warm side in winter) must be covered with material that will impede the natural drive of moisture to flow through the inside surfaces of exterior walls, toward the lower vapor pressure outside. To be effective, such a material must have a high resistance to moisture flow. The material is usually called “vapor barrier” or “vapor retarder.”

New Construction

- Choose wood or vinyl-sheathed wood rather than metal for windows and gliding doors. This will reduce the likelihood of condensation on the frame and sash. Wood is a better insulator than metal. Metal frames without thermal breaks conduct heat readily, so the inside surface of a metal window frame is cold in the winter. When humid air comes into contact with cold metal, condensation, and often freezing, occurs.
- Make sure the attic and crawl space are cross-ventilated. The crawl space should be covered with a vapor barrier. This will prevent water vapor from rising from the soil into your house.
- Make sure your clothes dryer and all gas appliances are vented to the outside. Water vapor is one of the products of gas combustion.
- If you have a basement, take the necessary steps to prevent leakage of soil moisture into the basement. These steps will vary with soil and drainage conditions on your lot.

Attic Ventilation

Ventilation of an attic or crawl space is very important to allow warm, moist air to escape to the outdoors.

If the insulation in your attic has a vapor barrier (which should be toward the floor, and not on top of the insulation where it may trap moisture), you should have at least one square foot of free vent opening (measurement of the opening not including the area taken up by screen or grillwork) for each 150 square feet of floor area. The net, free vent area should be specified on the vent itself, or the information should be available from the vendor. It is preferable that the vents be located such that one-half of the vents are low and one-half are high.

Don't try to substitute a vapor barrier for ventilation. According to Department of Housing and Urban Development standards, if you have a vapor barrier, you should still have one square foot of free vent opening for every 300 square feet of attic floor opening.

Turbine vents and attic ventilating fans are also useful for ventilation.

Note: Take care to install enough attic ventilation to meet the needs of your whole-house fan. Requirements should be listed on the instruction sheet or available from the manufacturer or vendor of the fan.

Wintertime Attic Ventilation

If the house is insulated, attic ventilation should not be covered in the winter. If warm, moist air in the attic condenses on the roof decking, it may melt and drip on attic insulation, causing the insulation to be ineffective. Warm air in the attic can also cause other roof problems.

Crawl Spaces

Crawl spaces should be vented to the outdoors in the summer. If the vents are located near each corner, the vents will permit good air movement through the crawl space. The total of all the vent areas where there is no vapor barrier as a ground cover should be at least one square foot for each 150 square feet of floor area. Where such a vapor barrier is used, the vent area may be reduced to 1/1,500 of the floor area.

Crawl space vents should be closed and sealed in the winter. Exception: When vents are used for combustion air-to-gas appliances located in the crawl space.

Note: If your foundation walls are insulated, the vents should have insulation placed over them in winter.

Water Heaters

Water heating is the third largest energy expense in the home, behind heating and air conditioning. Because a water heater is one of the large energy users, EnergyGuide labels are required. The labels are good guides for choosing the most efficient model you can afford.

The fuel you use to heat water is a big factor in water heating costs. If you have an electric water heater, the cost is probably two to three times as much.

When purchasing a new water heater, choose as small a tank as possible to meet your family's needs. In the upper right hand corner of the EnergyGuide label, you will find a listing of the First Hour Rating in gallons. This will tell you how many gallons of hot water that tank will produce in a single hour. Match that number to your needs.

Tank water heaters use either gas or electricity to heat water, then store 20 to 80 gallons in an insulated tank for use when a faucet is turned on. Heat is constantly lost through the tank walls (this is called standby heat loss which accounts for 20 percent to 60 percent of the total cost of heating water), and the gas burner has to reheat the same water even when no water is being used.

For tank-type water heaters, there are three main energy uses.

Demand costs are the initial heating costs of water. The energy usage for demand will vary from summer to winter with the temperature of the incoming water. Lowering the tank temperature, and water usage efficiency, will lower demand costs. Using less hot water is the best savings measure.

Standby losses amount to 20 percent to 60 percent of total water heating energy. Households using less hot water have a higher percentage of standby losses. Lowering the tank temperature and adding extra tank insulation will cut standby losses. With an electric resistance tank, the use of an automatic timer can reduce energy used to reheat water.

Distribution losses occur in pipes when hot water flows through them. Insulating pipes and short runs to plumbing fixtures will reduce distribution losses. Install a heat trap at the water heater to stop convection of hot water into the hot and cold water pipes above the water heater. Consider installing a small water heater, or an instantaneous heater, at the point of use to decrease your distribution losses substantially.

Instantaneous water heaters heat water as it is needed, using a gas burner or an electric element. The units can serve a single tap, or, as centralized heaters, to replace conventional tank water heaters. Although tankless water heaters will provide an endless source of hot water, most will provide the hot water at a slow flow rate (2 to 3 gallons per minute with a temperature rise of 90°F). Whether you should replace a conventional water heater with a tankless unit depends on the size and efficiency of the tank being replaced, the cost of energy used and the frequency and amount of hot water used. A tankless water heater is probably a good idea for a vacation home; or a household with small, and easily coordinated, hot water requirements; or a remote bathroom that could be served by a small point-of-use model. These heaters are more expensive to purchase.

Heat pump water heaters are more efficient than electric resistance units. A heat pump water heater uses a third to half as much electricity as a conventional electric resistance water heater. While the efficiency is higher, so is the purchase cost.

Batch solar water heaters are a do-it-yourself project that pays. These simple heaters preheat water using the sun's heat. They are inexpensive to build, and plans are available for their construction.

Hot Water Savings

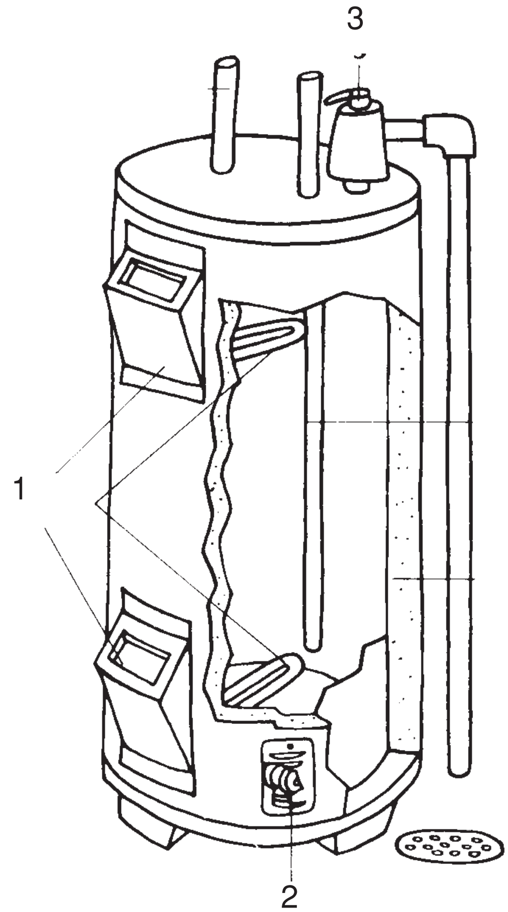
- Fix any hot water leaks promptly.
- Install high-efficiency showerheads. The Energy Policy Act of 1992 mandates that any showerhead manufactured after January 1, 1994, must not be more than a 2.5 gallon-per-minute flow (at 80 psi). Some showerheads have valves that allow water shut-off at the shower head without losing temperature mix.
- Low-flow faucet aerators for the kitchen are covered in the same legislation. They reduce flow to 2.5 gpm.
- Take short showers.
- Use your dishwasher wisely instead of washing dishes by hand.
- Set washer cycles for the lowest temperature and water amount that will get clothes clean.
- Always rinse on cold water setting.
- Set water heater temperature at 120°F – 130°F.

Water Heaters

Insulate your gas or electric water heater as shown in these illustrations. Caution: Improper installation can cause serious safety problems. It is very important to cut openings in the insulation to allow certain areas to breathe.

For ELECTRIC water heaters, you must NOT cover the following areas:

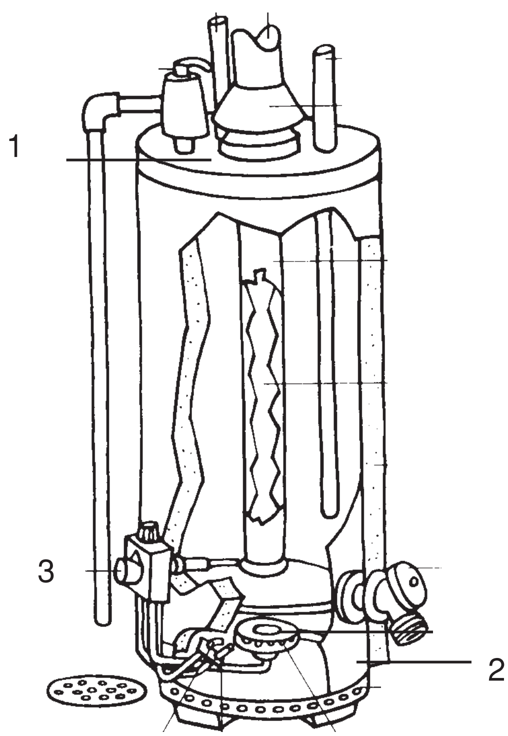
1. Access panels to the temperature controls.
2. The drain valve.
3. The pressure-temperature relief valve.



Electric

For GAS water heaters you must NOT cover the following areas:

1. The top of the tank.
2. Below the water tank line.
3. The temperature dial.



Natural Gas

Indoor Water Usage

The average family's indoor water usage is about 50 gallons of water per person per day. If your family's water usage is more than that amount, you need to look at your water use habits.

Flushing the toilet accounts for about 42 percent of the total, bathing is 32 percent, and laundry is 14 percent. The amount of water that is used for drinking or cooking is probably less than 4 percent of the total.

The Energy Policy Act of 1992 has maximum water-use standards for plumbing fixtures. Toilets manufactured after January 1, 1994, have a 1.46 gallon per flush flow (as opposed to 3.5 or 5 gallons per flush for older units), and showerheads will have a maximum flow rate of 2.5 gallons per minute. Replacing a showerhead or an older-model toilet, is a good investment.

Efficiency Hints

- Fix all leaks promptly.
- Don't let the water run while shaving or brushing your teeth.
- Use low-flow showerheads and faucet aerators.
- Take short showers and don't overfill the bathtub.
- Use your dishwasher wisely instead of washing dishes by hand.
- If you wash dishes by hand, don't let the water run for rinsing.
- Use full loads in your dishwasher and in the washing machine.

Lawn Irrigation

An irrigation system can be the most efficient method of watering a landscape if it is correctly designed, maintained and programmed according to plant needs and weather conditions. An owner should be aware of the system's operations and be alert to signs of trouble with equipment or scheduling. It's also important to adapt the system to maturing landscape and to consider improvements that can increase efficiency.

Good water management can improve lawn quality and lower bills. The choice of species of grass will determine water needs. A lawn of Kentucky bluegrass will demand higher input of water, chemicals and labor than any other type of grass. It needs more water than other grasses (1.2 inches weekly), but many owners give bluegrass excess water. Turf-type tall fescues have greater heat and drought tolerances than bluegrass and are better adapted to partial shade; they require only .8 inch of water per week; Zoysia or Bermuda grass lawns require only .5 inch per week.

Mowing height and frequency affect water consumption. Slightly taller grass will develop deeper, more drought-hardy roots. See page 27 for efficient landscaping suggestions.

Efficient Irrigation

- Water your lawn only when needed.
- Water grasses heavily and deeply when they begin to wilt. Frequent, shallow sprinklings produce poor root development.
- Water during the coolest part of the day; generally early in the morning.
- Don't water during windy conditions.
- Position sprinklers so they water the lawn, not the pavement.
- Use mulch on your garden and flower beds to help keep soil moist.

Other Outdoor Water Usage Suggestions

- Use a broom, not a hose, to clean driveways and sidewalks.
- Don't run the hose while washing your car.
- Avoid letting children play in the hose or sprinkler.
- Check and repair leaks in hoses, hose couplings and outside faucets.
- Plant drought-resistant plants and trees.
- Use a water timer on hose sprinklers.

Windows

Windows are the point of highest heat flow by conduction and radiation and are a significant point of air leakage. They are a difficult and expensive problem to treat. Replacement windows are seldom cost-effective as an energy-saving measure because of their high cost. If they save any energy, it is through an improvement in thermal resistance or reduced solar transmittance. Air leakage reduction is usually a secondary benefit.

Glazing Options

Until recently, conventional, clear glass was the primary glazing material available for residential use. Now several types of special glass are available that can help control heat loss or gain, including low-emissivity glass, heat-absorbing glass and reflective glass.

The National Fenestration Rating Council (NFRC) has developed a window rating system that considers solar heat gain in addition to R-value and air leakage.

Starting in 1996, NFRC rating will include two ratings between 0 and 70 that indicate annual heating and cooling performance as a tool for comparing windows. The numbers which represent the Fenestration Heating Ratio (FHR) and Fenestration Cooling Ratio (FCR) indicate the percentage of annual household heating or cooling energy the window will save compared to a worst-case window with single glazing and aluminum frame. The higher the number, the greater the savings.

Low emissivity glass, or low-e glass, has a special coating on the surface to reduce radiant heat transfer. While the air space in normal double-paned windows reduces some of the heat loss, a significant amount of heat is transferred from the warm inner pane to the colder outer pane through long-wave radiation. The coatings used on low-e glass reduce the emissivity, thereby increasing the R-value of double-paned units from 2.1 to a range of 2.5 to 3.2. The low-e coating also reflects outside heat and a portion of the incoming solar energy, thereby reducing heat gain. The incoming visible light is reflected only slightly, so low-e glass appears almost clear rather than mirror-like. Window units with low-e coatings cost about 10 percent to 15 percent more than regular units but can reduce energy flow though a window by 30 percent to 50 percent.

Heat absorbing glass contains special tints that allow it to absorb as much as 45 percent of the incoming solar energy, thereby reducing heat gain. Part of the absorbed heat, however, will continue to be passed to the structure. An inner layer of regular glazing reduces this transfer. Heat-absorbing glass reflects on a small percentage of visible light and, therefore, does not have the mirror-like appearance of reflective glass.

Reflective glass has been coated with a reflective film. It is useful in controlling solar heat gain during the summer, but it also reduces the passage of light all year long, and, like heat absorbing glass, reduces solar transmittance in winter. These two types of glass, therefore, are not desirable for use in passive solar heating applications.

Storm Windows

For homes with single-pane windows, adding storm windows can be as effective, or sometimes more effective, in blocking heat transfer than double-paned units. Several kinds of storm windows are available. The least expensive is plastic sheeting that can be installed around either the outside or, preferably, the inside of windows. Plastic films are available in kits or rolls. The major drawbacks to plastic films are that they are easily damaged, and some types reduce visibility through the window. To be effective, the film should fit tightly and not “flap” when it is windy.

Glass units with wood, metal or vinyl frames can be attached to the window frame with clips or screws. The energy savings and pay-back periods from storm windows depend on several factors and can range from several months to a year for plastic sheeting and 5 to 10 years for glass. More expensive units may not be cost effective.

Other options for improving existing windows’ resistance to heat loss and gain are movable insulation, shading devices and reflective films.

Movable insulation, such as insulating shades, shutters and drapes, can be installed on the inside of the window to reduce heat loss at night.

Shading devices, such as awnings, exterior shutters or screens, can be used to reduce unwanted heat gain in the summer.

Reflective films are another method of controlling the balance of heat gain and heat loss through windows. These films reflect sunlight away from the window and reflect heat back into the room.

"Integrity and excellence in all we do"

The Missouri Department of Natural Resources, Energy Center would like to thank the Chugach Electric Association, Inc. of Anchorage, Alaska and City Utilities of Springfield, Missouri for permission to modify and reproduce their homeowner handbook, which was the basis for for this publication.

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